
ROCKY MOUNTAIN REMEDIATION SERVICES, L.L.C. (ENVIROBOND™ SOLUTION)

TECHNOLOGY DESCRIPTION:

ENVIROBOND™ is a proprietary solution that binds with metals in contaminated soils and other wastes to form a virtually impenetrable chemical bond. Rocky Mountain Remediation Services, L.L.C., claims that the treatment process effectively prevents metals leaching and can be used with mechanical compaction to reduce the overall volume of contaminated media by 30 to 50 percent. The process generates no secondary wastes and requires minimal handling, transportation, and disposal costs. In addition, unlike some pozzolanic-based reagents, the ENVIROBOND™ liquid is safe to handle and does not generate any emissions.

ENVIROBOND™ consists of a mixture of additives containing oxygen, sulfur, nitrogen, and phosphorous; each additive has an affinity for a specific class of metals. ENVIROBOND™ converts metal contaminants from their leachable form to an insoluble, stable, nonhazardous metallic complex. ENVIROBOND™ is essentially a ligand that acts as a chelating agent. In the chelation reaction, coordinate bonds attach the metal ion to at least two ligand nonmetal ions to form a heterocyclic ring. The resulting ring structure is inherently more stable than simpler structures formed in other binding processes. By effectively binding the metals, the process reduces the waste stream's RCRA toxicity characteristic leaching procedure (TCLP) test results to less than the RCRA-regulated levels, subsequently reducing the risks posed to human health and the environment.

The stabilized waste can then be placed in a pit or compacted into the earth using traditional field compaction equipment, or it can be mechanically

compacted to produce a solid, compressed form called ENVIROBRIC™. The machine used to form the ENVIROBRIC™ is designed for mass production of sand-clay "rammed earth" bricks. Unlike conventional construction bricks, rammed earth bricks are produced under extremely high compaction forces and are not heated or fired. As a result, the bricks possess very high compressive strength and a correspondingly low porosity, making them ideal for on-site treatment by solidification/stabilization at industrial sites. The size of the individual bricks can be adjusted depending on specific site requirements, and the bricks have successfully passed various tests designed to measure their long-term durability.

WASTE APPLICABILITY:

The ENVIROBOND™ process does not reduce the overall concentration of metal contaminants; instead it converts them to metal-ligand compounds, rendering them insoluble and stable in the media. The developer claims that the process can be applied to contaminated soils and other media in both industrial and residential use scenarios. At residential sites, contaminated soil can be mixed with ENVIROBOND™ and stabilized before being disposed of off site. At industrial sites, ENVIROBOND™ can be mixed with contaminated waste streams or soils and then compacted in the ENVIROBRIC™ process and backfilled on site to reduce the overall volume of contaminated media.

Bench-scale and field tests indicate that ENVIROBOND™ can be added to waste streams containing more than four metal contaminants at concentrations ranging from 200 to more than 5,000 parts per million (ppm). TCLP tests have

shown that metals concentrations in leachate from treated media do not exceed RCRA regulatory levels. Metals that can be stabilized with ENVIROBOND™ include arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and zinc. However, the process is less effective in media containing more than 3 percent by weight of metals such as aluminum, magnesium, calcium, and manganese. These metals may reduce the number of chelating sites available by preferentially binding with the ENVIROBOND™ agent.

The ENVIROBOND process is capable of achieving high processing rates of 20 to 40 tons per hour and can be used with contaminated media containing as much as 10 percent debris and other matter. For acidic wastes with a pH of 3 or less, buffering compounds can be added to the contaminated media before it is mixed with ENVIROBOND™. Volatile organic compounds such as benzene, toluene, ethylbenzene, and xylenes do not affect the process.

STATUS:

Under a cooperative agreement with the Ohio EPA, the ENVIROBOND™ process was demonstrated in September 1998 at two separate areas of the Crooksville/Roseville Pottery site in Ohio. Soil at the site, some of it adjacent to

residential areas, is contaminated with lead from waste disposal practices associated with pottery production operations. Soil at the demonstration areas contains lead in concentrations ranging from 100 ppm to 80,000 ppm. The objective of the demonstration was to determine if the ENVIROBOND™ process can reduce the bioavailability of lead in the soil by 25 percent. Results of the demonstration will be available in early 1999.

FOR FURTHER INFORMATION:

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SANDIA NATIONAL LABORATORIES (In Situ Electrokinetic Extraction System)

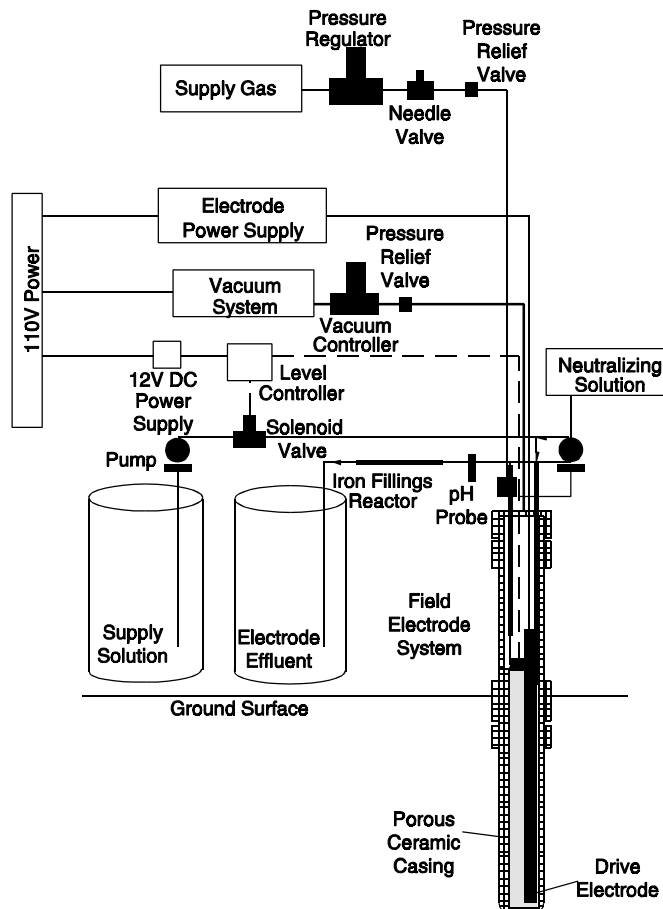
TECHNOLOGY DESCRIPTION:

Electrokinetic remediation has been used successfully to treat saturated soils contaminated with heavy metals. At some sites, however, it may not be desirable to add the quantities of water needed to saturate a contamination plume in the vadose zone. Sandia National Laboratories (SNL) has developed an electrokinetic remediation technology that can be used in unsaturated soils without adding significant amounts of water.

The SNL electrokinetic extraction system, shown in the figure below, consists of three main units: the electrode assembly (electrode casing and internal assemblies), the vacuum system, and the

power supply. The electrode casing consists of a porous ceramic end that is 5 to 7 feet long and has an outer diameter of 3.5 inches. During field installation, the casing is attached to the required length of 3-inch polyvinyl chloride pipe. The electrode internal assembly consists of the drive electrode, a water level control system, and a pump system. The vacuum system consists of a venturi vacuum pump and vacuum regulator that together supply a constant vacuum for the electrode. Up to four 10,000-watt power supplies can operate in either constant voltage or constant current mode.

When the drive electrode is energized, contaminants and other ions are attracted into the electrode casing. The water level control system



Schematic Diagram of the In Situ Electrokinetic Extraction System

adds water to, and extracts water from, the electrodes. Water is supplied to the electrode from a supply solution tank at the ground surface. This solution is either drawn into the electrode by the vacuum maintained in the electrode or by a supply pump. At the same time, water is continuously pumped out from the electrode casing at a constant rate. Part of the contaminated water is sent to an effluent waste tank at the ground surface; the remainder is returned to the electrode to maintain circulation of the fluid surrounding the electrode. A metering pump controlled by in-line pH meters regulates the introduction of neutralization chemicals to each electrode. Process control and monitoring equipment is contained in a 10-foot- by-40-foot instrument trailer.

WASTE APPLICABILITY:

SNL has developed its electrokinetic extraction system to treat anionic heavy metals such as chromate in unsaturated soil. There is no lower limit to the contaminant concentration that can be treated; however, there may be a lower limit on the ratio of contaminant ions to other ions in the soil.

The technology can be expanded to treat saturated soils. Soil that is highly conductive because of a high salinity content is not suitable for this technology. In addition, sites with buried metal debris, such as pipelines, are not appropriate.

STATUS:

This technology was accepted into the SITE Demonstration Program in summer 1994. The SITE demonstration began May 1996, at an unlined chromic acid pit within a SNL RCRA regulated landfill. The operation was completed in November 1996 and site closure was completed

in April 1997, with a closure report submitted to New Mexico state regulators in September 1997.

The demonstration verified the technology's capability of removing anionic contaminants from vadose zone soil through passive operation. Over 600 grams of hexavalent chromium were removed by the technology during the demonstration, equaling out to about 8 milligrams of chromium removed per kilowatt hour. Reports on the demonstration are in final preparation and should be available from EPA in early 1999.

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SELENTEC ENVIRONMENTAL TECHNOLOGIES, INC. (Selentec MAG*SEPSM Technology)

TECHNOLOGY DESCRIPTION:

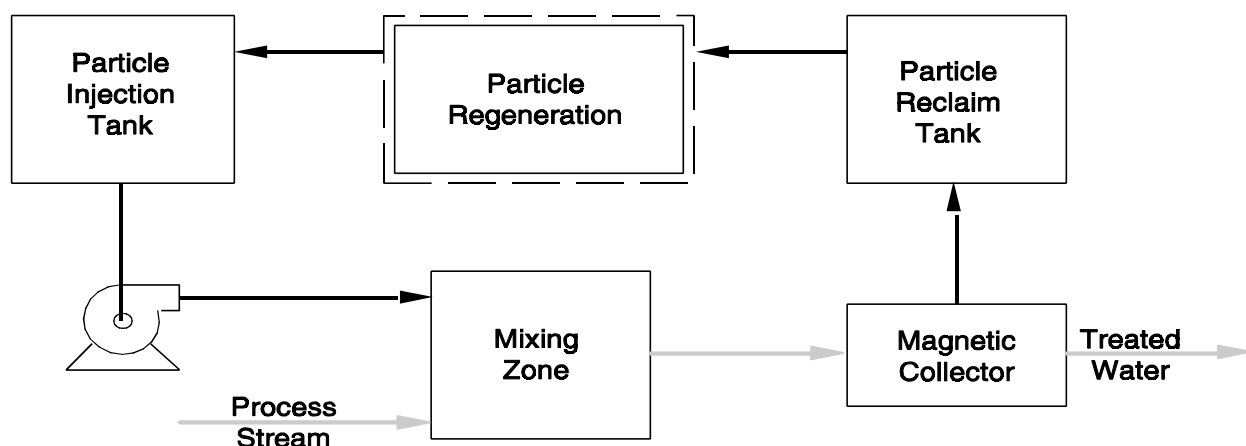
The MAG*SEPSM process uses the principles of chemical adsorption and magnetism to selectively bind and remove heavy metals or radionuclides from aqueous solutions such as groundwater, wastewater, and drinking water. Contaminants are adsorbed on specially formulated particles which have a core made from magnetic material; these particles are then separated (along with the adsorbed contaminants) from the solution using a magnetic filter or magnetic collector. The magnetic core has no interaction with the contaminant.

The proprietary adsorbing particles are made of a composite of organic polymers and magnetite. The particles can be manufactured in two forms: one with an ion exchanger and/or chelating functional group attached to the particle surface (amidoxime functionalized resin), or one with inorganic adsorbers bound to the surface of the particles (clinoptilolite). These particles have high surface areas and rapid adsorption kinetics.

A typical MAG*SEPSM treatment system consists of:

- a particle contact zone
- a particle handling system, including particle injection components, a magnetic separator, and particle reclaim components
- a particle regeneration system (where applicable)

The process stream enters a contact zone (usually a tank - other configurations are used for particular applications) where MAG*SEPSM particles are injected and mixed. The contact zone provides the necessary solution flow characteristics and contact time with the particles to ensure that the contamination will be adsorbed onto the active surface sites of the particles. The mixture then flows through a magnetic collector, where the contaminated particles are retained while the treated process stream passes through (see figure below).



Schematic Diagram of the Mag*SEPSM Treatment System

Depending on the application, type of particle, and contaminant concentration, the particles may be re-injected into the flow stream, collected and disposed of, or regenerated and reused. The regeneration solution is processed to recover (concentrate and remove) the contaminants and may be recycled.

The MAG*SEPSM process is able to selectively remove (either ex situ or in situ) the following contaminants from aqueous solutions: titanium, copper, cadmium, arsenic, cobalt, molybdenum, platinum, selenium, chromium, zinc, gold, iodine, manganese, technetium, mercury, strontium, iron, ruthenium, thallium, cesium, cobalt, palladium, lead, radium, nickel, silver, bismuth, thallium, antimony, zirconium, radium, cerium, and all actinides. The process operates at flow rates up to 2,000 gallons per minute (gpm).

WASTE APPLICABILITY:

The MAG*SEPSM technology reduces heavy metal and radionuclide contamination in water and wastewater. The technology has specific applications in environmental remediation and restoration, treatment of acid mine drainage, resource recovery, and treatment of commercial industrial wastewater. MAG*SEPSM particles can be produced to incorporate any known ion exchanger or sorbing material. Therefore, MAG*SEPSM can be applied in any situation where conventional ion exchange is used.

STATUS:

The MAG*SEPSM technology was accepted into the SITE Program in 1996 and is also one of 10 technologies participating in the White House's Rapid Commercialization Initiative. In addition, in 1997 the MAG*SEPSM technology received a Research and Development (R&D) 100 Award from the R&D trade publication as one of the 100 Most Technologically Significant New Products of 1997.

Selentec has completed a demonstration of the MAG*SEPSM technology at the U.S. Department of Energy's Savannah River Site. Heavy metal concentrations in coal pile runoff water were significantly reduced to below drinking water standards. Another demonstration of the technology is planned for Savannah River whereby radioactive cesium will be removed streams. The technology is also being used to remove mercury from heavy water drums at Savannah River.

The first commercial unit of the MAG*SEPSM technology was put into service on November 18, 1998, at a dairy in Ovruch, Ukraine. For this application, the unit is removing radioactive cesium from contaminated milk produced near the Chernobyl Nuclear Reactor Plant.

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SEVENSON ENVIRONMENTAL SERVICES, INC. (MAECTITE® Chemical Treatment Process)

TECHNOLOGY DESCRIPTION:

The patented MAECTITE® chemical treatment process for lead and other heavy metals uses reagents and processing equipment to render soils, waste, and other materials nonhazardous when tested by the Resource Conservation and Recovery Act toxicity characteristic leaching procedure (TCLP). The MAECTITE® process reduces leachable lead, hexavalent chromium, and other heavy metals to below treatment standards required by land-ban regulations. Lead in treated material, as determined by approved EPA methods (such as the TCLP, extraction procedure toxicity test, and the multiple extraction procedure), complies with limits established by EPA. The photograph below shows a 500-ton-per-day ex situ unit.



500-Ton-Per-Day MAECTITE®
Processing System

Chemical treatment by the MAECTITE® process converts leachable lead into insoluble minerals and mixed mineral forms within the material or waste matrix. MAECTITE® reagents stimulate the nucleation of crystals by chemical bonding to yield mineral compounds in molecular forms. These forms are resistant to leaching and physical degradation from environmental forces. The durability of traditional monolithic solidification-stabilization process end-products is often measured by geotechnical tests such as wet-dry, freeze-thaw, permeability, and unconfined compressive strength. The MAECTITE® process does not use physical binders, is not pozzolanic or siliceous, and does not rely on the formation of metallic hydroxides using hydration mechanisms. Therefore, these tests are not relevant to MAECTITE® product chemical stability, although engineered properties are readily obtained, if required. MAECTITE® is not pH dependent and does not use adsorption, absorption, entrapment, lattice containment, encapsulation, or other physical binding principles. The technology is a true chemical reaction process that alters the structure and properties of the waste, yielding stable compounds.

The MAECTITE® process uses water to assist in dispersing reagents. However, the dehydration characteristic of the process liberates water present in waste prior to treatment (absorbed and hydrated forms) to a free state where it can be removed from the waste matrix by evaporation and capillary drying principles. The ability of treated material to readily lose water, the formation of dense mineral crystals, and the restructuring of the material as a result of MAECTITE® treatment (where interstitial space is minimized), all contribute to reduced waste volume and weight.

Ex situ MAECTITE® processing equipment generally consists of material screening and sizing components, liquid and solid reagent storage delivery subsystems, and a mixing unit such as a pug mill. Equipment is mobile but can

be modified for fixed system operations. In situ MAECTITE® processing equipment is also available; system selection is largely dictated by contaminant plume configuration, soil characteristics, and site space limitations.

WASTE APPLICABILITY:

Materials that have been rendered nonhazardous include soils; sludges; sediments; battery contents, including casings; foundry sands; and firing range soil. Oversized material can be treated with the process as debris, but size reduction often makes processing more efficient. Even sludges with free liquids (as determined by the paint filter test) have been treated to TCLP compliance when excess fluids are present.

The range of lead levels effectively treated has not been fully determined; however, soils with total lead as high as 30 percent by weight and TCLP values over 15,000 milligrams per liter (mg/L) were not problematic. Common lead levels encountered have averaged from 200 milligrams per kilogram to 6,500 with TCLP concentrations averaging 20 to 400 mg/L. Material geochemistry most often dictates final MAECTITE® treatment designs. Furthermore, correlations between total lead and regulated leachable lead levels are inconsistent, with treatment efforts more strongly related to the geochemical characteristics of the waste material.

STATUS:

The chemical treatment technology was initially accepted into the SITE Demonstration Program in March 1992. EPA is seeking a suitable demonstration site.

Sevenson Environmental Services, Inc. (Sevenson), acquired the MAECTITE® technology in 1993 and was issued second, third and fourth patents in 1995, 1996, and 1997 respectively. Combining ex situ and in situ quantities, over 650,000 tons of material has been successfully processed. Treatability studies have been conducted on over 100 different materials in over 40 states, Canada, Italy, and Mexico. The technology has been applied at full-scale demonstration and remedial projects in over 25 states and in all 10 EPA regions.

The MAECTITE® process has been formally accepted into the EPA PQOPS program for the fixation-stabilization of inorganic species. Proprietary technology modifications have shown promise in rendering radionuclides nonleachable using gamma spectral counting methods on TCLP extract.

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SIVE SERVICES **(Steam Injection and Vacuum Extraction)**

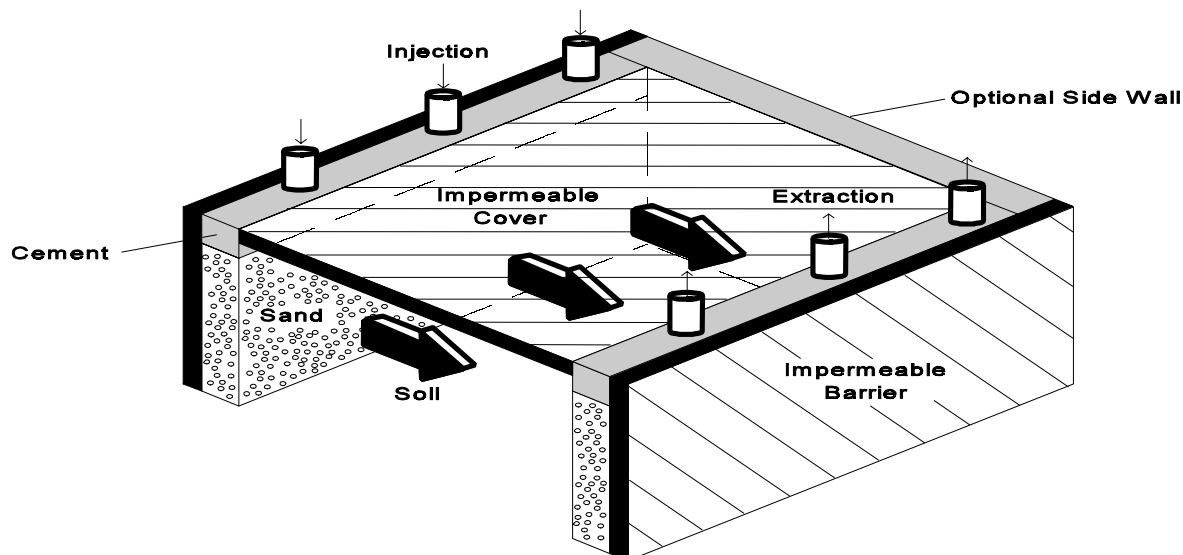
TECHNOLOGY DESCRIPTION:

Steam Injection and Vacuum Extraction (SIVE) uses steam injection wells in conjunction with dual-phase extraction wells for in situ treatment of contaminated soil and groundwater. The injected steam strips volatile and semivolatile organic compounds as it permeates the contaminated zones. The steam increases the subsurface temperature, which increases mass transfer and phase exchange rates, reduces liquid viscosities, and accelerates desorption of contaminants from the matrix. The moisture and warmth provided by the steam also accelerates biodegradation of residual contaminants. As a result, contaminants are extracted or degraded at increased rates as compared to conventional isothermal vapor and liquid extraction systems.

SIVE-LF (Linear Flow) is an enhanced SIVE method designed for relatively shallow depths. With the SIVE-LF process, as illustrated in the figure below, steam is forced to flow horizontally

and uniformly from one trench, through the contaminant zone, and into another trench, from which the contaminants are extracted. The large open area of the trench faces allow for high injection and extraction rates, which promote low treatment duration. The trenches also allow for installation of an impermeable barrier, such as a polyethylene liner, against one face of the open trench before the trench is backfilled, thus reducing the flow of injected or extracted fluid outside the area of the targeted zones. A surface covering for the treatment area prevents short-circuiting of the flow of injected steam to the atmosphere, and prevents atmospheric air from entering the extraction trench.

Surface equipment for SIVE includes conventional steam generation and delivery systems, and the vacuum extraction system. The vacuum extraction system includes a vacuum blower, steam condenser, other cooling components, and air emission control devices. The condensate generated by the process requires



The SIVE-LF Process

further treatment or off-site disposal. The reliability of the equipment and automatic controls allows SIVE to operate without constant direct supervision.

WASTE APPLICABILITY:

SIVE may be applied to soil or groundwater contaminated with fuels, industrial solvents, oils, and other liquid toxics, and may be applied at any depth. The SIVE-LF process is designed to treat to depths of 30 feet. Because highly volatile contaminants are readily air-stripped without the added effects of steam, the steam-stripping effect will be greatest on the heavier, less volatile contaminants. SIVE also effectively removes floating non aqueous-phase liquids from groundwater.

STATUS:

This technology was accepted into the SITE Demonstration Program in summer 1994. A suitable site for the demonstration is being sought, although at this time the project is considered inactive.

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STAR ORGANICS, L.L.C. **(Soil Rescue Remediation Fluid)**

TECHNOLOGY DESCRIPTION:

Star Organics, L.L.C., has developed a liquid remediation solution that binds heavy metal contaminants in soils, sludges, and aqueous solutions. The liquid, called Soil Rescue, consists of organic acids that occur naturally in trace concentrations in soil. The liquid is typically sprayed onto and then tilled into the contaminated media; the application process can be repeated until the metals concentration in the media are reduced to below the applicable cleanup standards. Laboratory and pilot-scale tests have shown that metals concentrations can be reduced to below Research Conservation and Recovery Act (RCRA) regulatory levels.

The Soil Rescue solution does not destroy or remove toxic concentrations of metals. Instead, organic acids in the solution bond with the metals to form more complex metallic compounds in a process known as chelation. Soil Rescue is essentially a ligand that acts as a chelating agent. In the chelation reaction, coordinate bonds attach the metal ion to least two ligand organic compounds to form a heterocyclic ring. The resulting ring structure is inherently more stable than simpler structures formed in other binding processes.

By effectively binding the metals, the process reduces the waste stream's toxicity characteristic leaching procedure (TCLP) test results to less than the RCRA-regulated levels, subsequently reducing the risks posed to human health and the environment. Once the toxic metals are bound to the ligand, the bond appears to be irreversible. The permanence of the bond has been tested using all recognized EPA test procedures for such determinations, including exposure to boiling acids.

The Soil Rescue process offers the following advantages over some treatment options: (1) it minimizes the handling and transport costs associated with treatment and disposal, (2) it requires no air monitoring because it release no

emissions, (3) its liquid application procedure minimizes fugitive dust emissions, (4) it generates no effluent, (5) it requires no stockpiling of contaminated soil, and (6) it minimizes exposure risks for workers because it is sprayed directly onto the contaminated media.

WASTE APPLICABILITY:

The Soil Rescue solution has been shown to be effective in reducing concentrations of barium, cadmium, chromium, copper, lead, mercury, selenium, and zinc. In situ remediation of heavy metal contaminated soil may be possible in moderately permeable soils. In dense or heavily compacted soils, the remediation procedure may require soil excavation and application of the Soil Rescue solution to moisten the media, followed by mixing in a rotating cylinder. This procedure can be repeated until the metals concentrations in the soil are sufficiently reduced to allow the soil to be replaced as backfill in its original location. At a soil pH of 5.0, a single application can reduce lead concentrations of 1,000 parts per million (ppm) to below the EPA maximum permissible level; with a second application of the remediation fluid, lead concentrations can be reduced to below the RCRA regulatory limit of 5 ppm.

STATUS:

Under a cooperative agreement with the Ohio EPA, the Soil Rescue technology was demonstrated in September 1998 at two separate areas of the Crooksville/Roseville Pottery site in Ohio. Soil at the site, some of it adjacent to residential areas, is contaminated with lead from waste disposal practices associated with pottery production operations. Soil at the demonstration areas contain lead in concentrations ranging from 100 ppm to 80,000 ppm. The objective of the demonstration was to determine if the Soil Rescue process can reduce the bioavailability of lead in the soil by 25 percent. Results of the demonstration will be available in early 1999.

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U.S. AIR FORCE (Phytoremediation of TCE-Contaminated Shallow Groundwater)

TECHNOLOGY DESCRIPTION:

The U. S. Air Force (USAF) has initiated a field demonstration designed to evaluate the effectiveness of eastern cottonwood trees in remediating shallow groundwater contaminated with trichloroethene (TCE). Using vegetation to remediate contaminated soil and groundwater is known as phytoremediation.

Phytoremediation of groundwater involves planting deep-rooted, water-loving vegetation to reduce contaminant levels in the saturated zone. The USAF's demonstration entails planting and cultivating eastern cottonwood trees over a dissolved TCE plume in a shallow (6 to 11 feet below grade) alluvial aquifer.

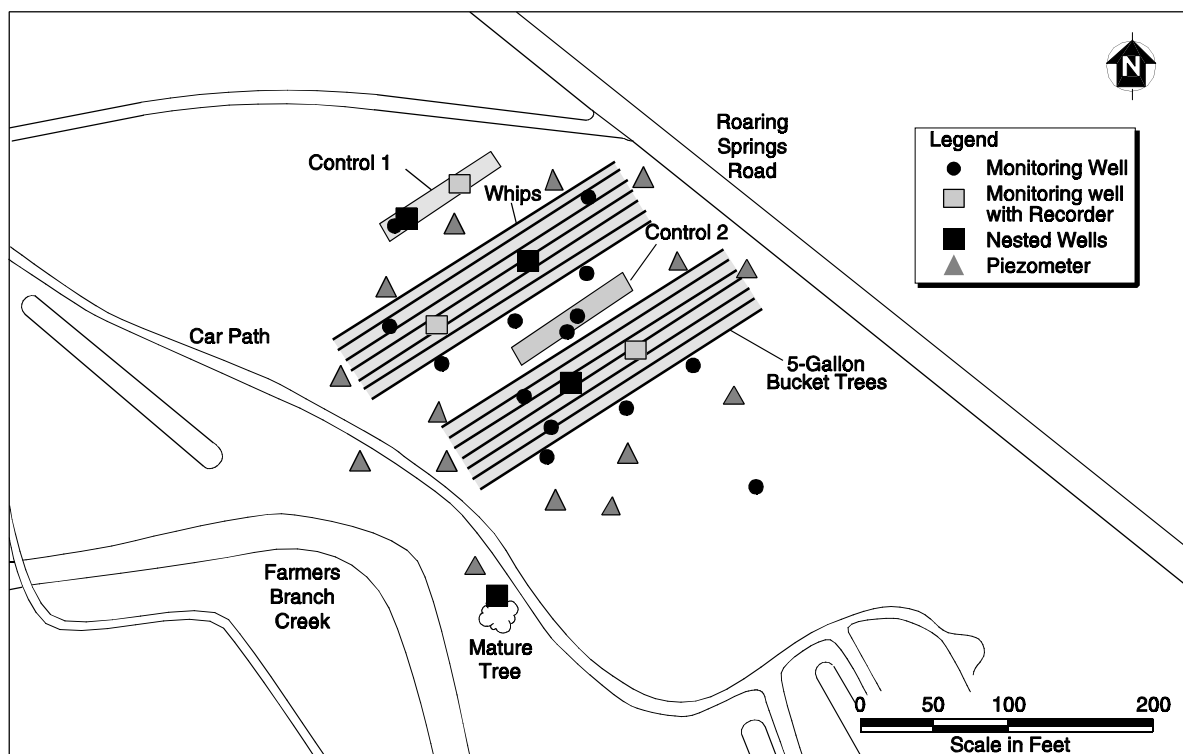
The cottonwood trees are expected to bioremediate the contaminated groundwater and

any contaminated soil through one or more of the following mechanisms:

- Release of root exudates and enzymes stimulating microbial activity in the rhizosphere and enhancing biochemical transformations of contaminants
- Metabolism or mineralization of contaminants within the vegetative tissues; the contaminated water enters the vegetative tissues by root uptake from the aquifer
- Transpiration of water by the leaves

In essence, the trees are expected to serve as a natural pump-and-treat system.

TCE concentrations in the groundwater, soil from the rhizosphere, and tree tissues will be



Schematic Diagram of the Site Layout at Navel Air Station Ft. Worth

monitored during the demonstration. In general, data will be gathered and interpreted to identify the overall effect of the planted trees on the dissolved TCE plume in the aquifer. Groundwater levels and TCE concentrations in the aquifer will be measured initially to establish baseline conditions and subsequently to map changes in the aquifer throughout the demonstration period. Changes in the flow field and the position of the TCE plume will also be modeled.

TCE concentrations will also be monitored in the soil from the rhizosphere and in the tree tissues. Ratios of daughter and parent compounds will be calculated for groundwater, soil, and tissue samples collected throughout the demonstration period. Microbial activity in the rhizosphere will be monitored and transpiration rates will be measured. These data will be used to determine the fate of the TCE at the site, including those processes that affect its fate.

WASTE APPLICABILITY:

The USAF's phytoremediation technology may be used to remediate shallow groundwater and soil contaminated with TCE, as well as other contaminants common to USAF installations. Such contaminants include petroleum, munitions, and halogenated hydrocarbons. Costs of the technology are limited to initial site preparation, planting, and occasional maintenance (irrigation).

STATUS:

The technology was accepted into the SITE Demonstration Program in 1996. The USAF is currently demonstrating its phytoremediation technology on a TCE plume near Air Force Plant 4 at the Naval Air Station Ft. Worth, formerly Carswell Air Force Base in Fort Worth, Texas.

Initial site characterization and final site selection were completed in January 1996. Site development, which included planting trees and installing the irrigation system, was completed in April 1996. The figure on the previous page details the layout of the site. Baseline sampling began in June 1996, and demonstration sampling is scheduled to continue until 2000. Preliminary data may be obtained from either of the below listed contacts.

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VORTEC CORPORATION (Vitrification Process)

TECHNOLOGY DESCRIPTION:

Vortec Corporation (Vortec) has developed an oxidation and vitrification process for remediating soils, sediments, sludges, and mill tailings contaminated with organics, inorganics, and heavy metals. The process can vitrify materials introduced as dry granulated materials or slurries.

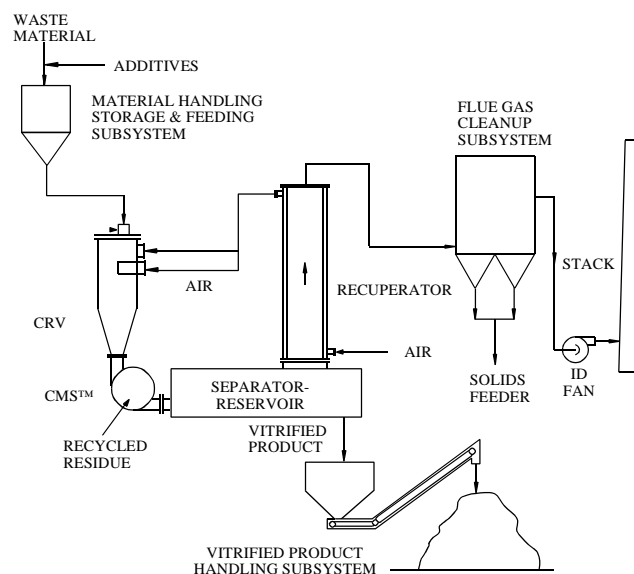
The figure below illustrates the Vortec vitrification process. Its basic elements include (1) a cyclone melting system (CMS™); (2) a material handling, storage, and feeding subsystem; (3) a vitrified product separation and reservoir assembly; (4) an air preheater (recuperator); (5) an air pollution control subsystem; and (6) a vitrified product handling subsystem.

The Vortec CMS™ is the primary system and consists of two major assemblies: a counterrotating vortex (CRV) reactor and a cyclone melter. First, slurried or dry-contaminated soil is introduced into the CRV.

The CRV (1) provides a high temperature environment; (2) preheats the suspended waste materials along with any glass-forming additives mixed with soil; and (3) destroys any organic constituents in the soil. The average temperature of materials leaving the CRV reactor chamber is between 2,200 and 2,800 °F, depending on the melting characteristics of the processed soils.

The preheated solid materials exit the CRV and enter the cyclone melter, where they are dispersed to the chamber walls to form a molten glass product. The vitrified, molten glass product and the exhaust gases exit the cyclone melter through a tangential exit channel and enter a glass- and gas-separation chamber.

The exhaust gases then enter an air preheater to heat the incoming air and are subsequently delivered to the air pollution control subsystem for particulate and acid gas removal. The molten glass product exits the glass- and gas-separation chamber through the tap and is delivered to a water quench assembly for subsequent disposal.



Vortec Vitrification Process

Unique features of the Vortec vitrification process include the following:

- Processes solid waste contaminated with both organic and heavy metal contaminants
- Handles waste quantities ranging from 5 to more than 400 tons per day
- Recycles particulate residue collected in the air pollution control subsystem into the CMS™. These recycled materials are incorporated into the glass product.
- Produces a vitrified product that is nontoxic according to EPA toxicity characteristic leaching procedure (TCLP) standards. The product has long-term stability.

WASTE APPLICABILITY:

The Vortec vitrification process treats soils, sediments, sludges, and mill tailings containing organic, inorganic, and heavy metal contamination. Organic materials included with the waste are successfully destroyed by the high temperatures in the CRV. The inorganic constituents in the waste material determine the amount and type of glass-forming additives required to produce a vitrified product. This process can be modified to produce a glass cullet that consistently meets TCLP requirements.

STATUS:

The Vortec vitrification process was accepted into the SITE Emerging Technology Program in May 1991. Research under the Emerging Technology Program was completed in winter 1994, and Vortec was invited to participate in the SITE Demonstration Program.

Construction of a 1.5-ton-per-hour, transportable system for treating contaminated soil at a Department of Energy site in Paducah, Kentucky, was initiated in October 1996. A SITE demonstration is expected to occur in early 1999.

A 50-ton-per-day system has been purchased by Ormet Aluminum Corporation of Wheeling, West Virginia for recycling aluminum spent pot liners, which are considered cyanide- and fluoride-containing wastes (K088). The recycling system became operational in 1996. Vortec is offering commercial systems and licenses for the CMS™ system.

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